PROJECT facts

U.S. Department of Energy
National Energy Technology Laboratory

Gasification Technologies

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Developing Reliable High Temperature Sensing Techniques

Description

Gasification systems operate at extreme conditions to produce synthesis gas from a variety of feedstocks such as coal or petroleum coke. Those extreme conditions include temperatures as high as 1600 ºC, large heat fluxes, high corrosion rates, elevated pressures (400 psi and higher), particulates, and a reducing or slagging environment. Under those conditions, traditional thermocouples fail or burn out in less than 30-45 days, depending upon the location of the probe. Burn out is due, primarily, to the limitations of the materials, which cannot withstand attacks by the chemical constituents at high temperatures and pressures.

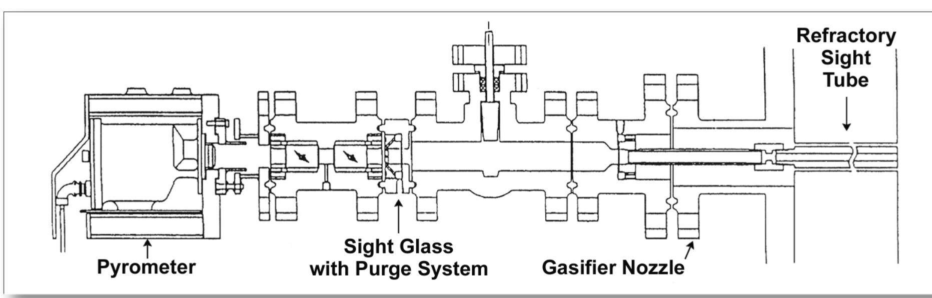
Because measuring temperature is a basic function for monitoring and controlling a gasification system, temperature sensing techniques, that improve upon the survivability and performance of thermocouples, are needed. New materials and techniques for direct or inferred temperature measurements are areas where improvements can be made.

Goals

The goal is to develop temperature sensing techniques and instrumentation that are robust enough to withstand these harsh conditions for up to one year and provide accurate temperature data that can be used to enhance the control of gasification systems.

Benefits

A successful temperature sensing system will directly benefit the operation of gasification systems by providing necessary data to control the system, which is turn will enhance the reliability and availability of the system. Specific benefits from this crucial measurement include 1) reducing the refractory wear, 2) maintaining high carbon burnout, 3) optimizing the feed and oxygen ratio into the system, and 4) minimizing byproduct formation. Robust temperature sensing techniques will also benefit other advanced power generation technologies where harsh conditions exist.



Texaco's Infrared Ratio Pyrometer System for the Measurement of Reaction Chamber Temperature

NETL

Developing Reliable High Temperature Sensing Techniques

Project Descriptions

Four cost-shared cooperative agreements have been selected to develop temperature-sensing techniques for use in a gasification system. Each project will demonstrate its respective technique beyond the laboratory and may include a full-scale field demonstration.

1) Development of a Single-crystal Sapphire Fiber Temperature Sensor

Virginia Tech

The Photonics Laboratory at Virginia Tech is currently developing a reliable single-crystal sapphire fiber temperature sensor. Three different single crystal sapphire based sensing configurations (Fabry-Parot interferometry, intensity-based Polarized-Light Interferometric Sensor (PLIS), and spectrum-based PLIS have been successfully tested. Laboratory testing of the sensors yielded an average resolution better than 1 ºC for a temperature range up to 1200 ºC and excellent corrosion resistance. The spectrum-based PLIS system has been selected for prototype development because it is simplified system where interferences, such as black body radiation, can easily be resolved. The prototype sensor will be designed and prepared for field testing at Dynegy's Wabash gasification facility.

2) Use of Thermographic Phosphors for On-line Measurement of Temperature in Gasification Processes

FluoreScience Inc.

FluoreScience, Inc. is utilizing novel thermographic phosphors (TPs) to detect temperature in the gas-exit and slag-exit regions of a gasifier. The non-contact phosphor thermometry technique has been demonstrated in the laboratory at temperatures as high as 1600 ºC. The proposed field application of the technique will utilize a proprietary probe housing design from Delta Controls, sapphire fibers for signal transmission, and a newly developed proprietary detector package. Current efforts are focused on the deposition of the phosphor material onto the ceramics for the sensing portion of the probe.

3) Development of a Millimeter-wave Pyrometer for Gasification Temperature Measurements

Integrated Environmental Technologies, Inc.

Integrated Environmental Technologies, Inc. is adapting a millimeter-wave pyrometry technique, where an optically thick millimeter-wave frequency will be used to make direct, non-contact measurements of the hot gas. Extensive bench tests have established a minimum resolvable temperature of 2 ºC with maximum measurable temperatures near 2500 ºC. A 3.13-mm (94 GHz) pyrometer system has demonstrated the ability to detect surface temperature. Future efforts will be to modify the pyrometer to detect the gas path temperature.

4) Design and Testing of a Texaco Infrared Ratio Pyrometer System for Gasification Temperature Measurements

Texaco Inc. Montebello Technology Center

Texaco's Montebello Technology Center has developed a non-contact infrared ratio pyrometer that exhibits faster response times and higher reliability than thermocouples. The pyrometer system includes an optical train that bolts to the gasifier, a purge cabinet that houses valves and instruments to monitor and control the optical port purge, and a control cabinet that houses the Programmable Logic Controller to control the system. The optical train attaches the infrared ratio pyrometer camera to the end of the optical access port and provides pressure containment, gas purging, and safety shutdown functions. The entire system has been tested at the bench scale and pilot scale and is now being prepared for field demonstration at Tampa Electric's Polk Power Station.

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